

REMARKS

This paper is filed in response to the office action mailed on November 12, 2004. Claims 30, 33-35, 37, 39, 41, 44 and 46-49 have been amended; claims 50 and 51 have been added; no claims have been canceled; claims 30-51 remain pending.

Claims 33-34 and 46-49 stand rejected under 35 U.S.C. § 112, second paragraph as allegedly being indefinite. In response, the terms "type" have been removed from claims 33 and 34. Further, claim 46 has been amended to recite "an acidity regulating composition in such an amount so as to keep a pH of said slurry in a range of from about 1 to about 7." Applicants respectfully submit that this language is sufficiently definite. Applicants also respectfully submit that this amendment traverses the indefiniteness rejection of claim 47 and claims 48-49. Claim 47 has also been amended, however, to recite "the pH" and claims 48 and 49 have been amended to recite "said acidity regulating composition comprises" as opposed to "said acidity regulating compound is."

Applicants respectfully submit that all claims are sufficiently definite and in full compliance with 35 U.S.C. § 112, second paragraph.

Turning to the rejections based upon the prior art, all claims stand rejected under 35 U.S.C. § 103 as being obvious in view of various combinations of prior art references including: (1) U.S. Patent Application Publication No. 2003/0166337 ("Wang '337"), U.S. Patent Application Publication No. 2003/0170991 ("Wang '991"), U.S. Patent Application Publication No. 2003/0076932 ("Dirksen"), applicants' admitted prior art (AAPA) and U.S. Patent Application Publication No. 2002/0197935 ("Mueller"); (2) Dirksen, Wang '337, AAPA and Mueller; (3) U.S. Patent No. 6,316,365 ("Wang '365"), Wang '337, AAPA and Mueller; (4) Wang '991, Dirksen, Wang '337, AAPA and Mueller; (5) Mueller, Dirksen, Wang '337 and APPA; and (6) U.S. Patent No. 6,740,590 ("Yano"), U.S. Patent No. 5,866,031 ("Carpio"), AAPA and Mueller.

In response, independent claims 30 and 46 have been amended to traverse these rejections. Method claims 30 and 46 require a RTN thin film to be formed on top of a pattern interlayer insulating layer and that the CMP process be performed on the RTN thin film to planarize the RTN thin film with the patterned interlayer insulating layer without causing dishing of the interlayer insulating layer as illustrated in Fig. 3 and in contrast to Fig. 2 of the present application.

Claim 30 also requires the amount of ceric ammonium nitrate to be present in a greater weight percent than that of the acid. Similarly, claim 46 requires that the ceric ammonium nitrate also be present in a greater weight percent than the weight percent of the acid that forms part of the acidity regulating composition. Therefore, both independent claims 30 and 46 require that there be a greater amount (weight percent) of ceric ammonium nitrate (CAN) than acid. Support for this limitation is formed when comparing the superior polishing speeds of Examples 2/7 and 3/8 and Examples 1/6, 4/9 and 5/10 of the present application (pp. 14-16). Specifically, when CAN is used in a greater wt% than the acid, superior polishing speeds (700Å/min in Example 7 and 950Å/min in Example 8) are achieved in comparison to when more acid than CAN is used (550Å/min in Example 9, 650Å/min in Example 10).

Further, both claims require a CMP process that planarizes a ruthenium titanium nitride (RTN) thin film with a patterned interlayer insulating layer with causing dishing to the interlayer insulating layer. Support for this limitation is found on page 11 of the present application. Applicants respectfully submit that no combination of the numerous references relied upon by the Patent Office in each obviousness rejection teaches or suggests either of these two limitations. Further, applicants respectfully submit that there is no teaching or suggestion found in the references themselves or in the prior art known to those of ordinary skill in the art to make the required changes to the references so as to make the references or a reasonable combination of the references read on amended claims 30 and 46.

Specifically, to establish a *prima facie* case of obviousness, under MPEP §§ 2142 and 2143,

[t]o establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure.

Citing, In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991); *see also* MPEP § 2143-§ 2143.03 for decisions pertinent to each of these criteria.

Regarding the first obviousness rejection based upon Wang '337, Wang '991, Dirksen, AAPA and Mueller, applicants respectfully submit that this rejection is improper because the proposed combination fails to teach or suggest every claim limitation of amended claims 30 and 46 and there is no teaching or suggestion in any of these references which would indicate to one of ordinary skill in the art to use ceric ammonium nitrate in a CMP slurry with an acid but in a greater amount than the acid and use the slurry on a RTN thin film to planarize the RTN thin film with a patterned interlayer insulating layer.

Specifically, the base reference, Wang '337, is not directed toward slurries for RTN films. While Wang '337 indicates that it could be used on a ruthenium film, Wang '337 does not address any of the special problems associated with RTN thin films. Further, Wang '337 lists a number of metal films to which its slurries could be used. Nowhere in Wang '337 does it make the connection between cerium ammonium nitrate and RTN. Wang '337 merely lists numerous oxidizing agents and numerous metal films. Nowhere is the connection between CAN and RTN taught or suggested by Wang '337. Further, nowhere is it suggested in Wang '337 that CAN be used in combination with an acid but in a greater weight percent than the acid.

Instead, one of ordinary skill in the art would look at the main teaching of Wang '337, which is the use of α -amino acids in CMP systems. Wang '337 in no way teaches or suggests any relationship between RTN thin films, patterned interlayer insulating films, ceric ammonium nitrate and an accompanying acid. Accordingly, Wang '337 is clearly deficient as a base reference.

Wang '991, on the other hand, is directed toward polishing additives that are phosphorous containing compounds. Wang '991 only merely states that its slurries could be used on ruthenium films, but in no way teaches or suggests that its slurries could be used on RTN films. Wang '991 only vaguely states that oxidizing agents can include cerium compounds, but in no way teaches or suggest ceric ammonium nitrate or any connection between ceric ammonium nitrate and RTN thin films. Instead, one skilled in the art would look to Wang '991 for its teaching of phosphorous containing additives.

Thus, no combination of Wang '337 and Wang '991 teaches any connection between CAN and RTN thin films and any relationship between weight percentages of CAN and an acid in a CMP slurry designed for RTN thin films and planarizing a RTN thin film with a patterned interlayer insulating layer.

The next, reference, Dirksen merely teaches the use of inorganic acids as pH adjusters. However, Dirksen also fails to teach or suggest any connection between CAN and RTN thin films. Dirksen merely vaguely teaches that ceria oxides can be used as metal oxide abrasives. This vague teaching of the use of ceria is not connected in any way to RTN thin films in Dirksen. Instead, Dirksen merely makes the broad statement that its slurries can be used on various metal films, including ruthenium films. However, there is no connection made in Dirksen between CAN and RTN thin films. There is no teaching or suggestion in Dirksen that the use of CAN and an acid could avoid the dishing phenomenon illustrated in Fig. 2 of the present application. Thus, Dirksen fails to supplement Wang '337 and Wang '991.

The next, reference, Mueller was cited for the proposition that it teaches conventional polishing parameters. However, Mueller also fails to make any connection between CAN and RTN. Mueller only vaguely states that oxides of ceria can be used in polishing systems and that its polishing systems can be used on ruthenium films. Nowhere in Mueller is RTN suggested or any connection between CAN and RTN. Nowhere in Mueller is it taught or suggested that CAN should be present in a greater weight percent amount than an acid. Thus, Mueller also fails to supplement Wang '337, Wang '991 and Dirksen.

Finally, the AAPA merely describes the conventional slurries and their end product as shown in Fig. 2 of the present application. AAPA does not teach or suggest the use of CAN in combination with an acid but in a greater weight percent than the acid or any way to avoid the dishing phenomena illustrated in Fig. 2 of the present application.

Accordingly, in view of the above remarks, applicants respectfully submit that the rejection of claims 30-42 and 46-48 as being obvious in view of Wang '337, Wang '991, Dirksen, AAPA and Mueller is improper and should be withdrawn.

Next, the office action rejects claims 30-42 and 46-48 under 35 U.S.C. § 103 as being obvious in view of Dirksen, Wang '337, AAPA and Mueller. This rejection is respectfully traversed for the reasons set forth above. Dirksen is clearly deficient as a base reference as it does not teach or suggest the use of CAN, the use of CAN with an acid but in a greater weight percent of an acid and the use of such a slurry on a RTN film to planarize a RTN film with a patterned interlayer insulating layer. Neither does Wang '337, AAPA or Mueller. Accordingly, the rejection of claims 30-42 and 46-48 as being obvious in view of Dirksen, Wang '337, AAPA and Mueller is improper and should be withdrawn.

Next, the office action rejects claims 30-42 and 46-48 as being obvious in view of Wang '365, Wang '337, AAPA and Mueller. Applicants respectfully submit that this rejection is improper for the following reasons.

At the outset, the base reference, Wang '365 is as vague as the other references in that it merely teaches the use of a metal oxide abrasive that includes ceria. Wang in no way teaches or suggests ceric ammonium nitrate. Wang '365 only vaguely states that the conductive metal being polished could be ruthenium but Wang '365, like the other references, fails entirely to make any connection CAN and RTN thin films or address the problems associated with RTN thin films. Wang '365 in no way teaches or suggests any planarizing of a RTN thin film with a patterned interlayer insulating layer. Wang '365 in no way teaches or suggests the use of CAN in an amount greater than an accompanying acid. As noted above, neither does Wang '337, the AAPA or Mueller.

Accordingly, applicants respectfully submit that the rejection of claims 30-42 and 46-48 as being obvious in view of Wang '365, Wang '337, AAPA and Mueller is improper and should be withdrawn.

Next, the office action rejects claims 30-42 and 46-48 as being obvious in view of Wang '991, Dirksen, Wang '337, AAPA and Mueller. This rejection is essentially the same rejection as set forth above with the substitution of Wang '991 as the base reference instead of Wang '337. However, as noted above, neither Wang '337 nor Wang '991 are suitable base references and neither is Dirksen or Mueller. No combination of these four references with the AAPA teaches or suggests all of the claim limitations of amended claims 30 and 46 or provide any suggestion as to how to modify the references in order to arrive at all of the claim limitations of amended claims 30 and 46. Accordingly, applicants respectfully submit that the obviousness rejection based upon Wang '991, Dirksen, Wang '337, AAPA and Mueller is improper and should be withdrawn as it fails to establish a *prima facie* case of obviousness.

Next, the office action rejects claims 30-37, 39-42 and 46-48 under 35 U.S.C. § 103 as being obvious in view of Mueller, Dirksen, Wang '337 and AAPA. In this rejection, Mueller is used as the base reference. However, Mueller fails entirely to teach or suggest any connection between RTN thin film and the use of CAN with an acid but in a greater amount than the accompanying acid. Mueller fails entirely to teach or suggest any planarization scheme for a RTN film deposited on top of a patterned interlayer insulating layer. As noted

above, neither does Dirksen or Wang '337 or the AAPA. Accordingly, applicants respectfully submit that the rejection of claims 30-37, 39-42 and 46-48 as being obvious in view of Mueller, Dirksen, Wang '337 and the AAPA is improper and should be withdrawn.

Finally, the office action rejects claims 30-49 under 35 U.S.C. § 103 as being obvious in view of Yano, Carpio, the AAPA and Mueller. In this rejection, Carpio and Yano appear to be used as co-based references. In any event, the rejection is improper for the following reasons.

One of the base references, Yano fails entirely to teach or suggest any planarization scheme for a RTN thin film disposed on a patterned interlayer insulating layer. Yano does not address the problems associated with RTN thin films at all. Yano does not address the dishing problem illustrated in Fig. 2 of the present application at all. Yano does suggest the use of cerium diammonium nitrate as an oxidizing agent; however, Yano makes no connection between the use of this material and RTN thin films. Yano makes no suggestion that cerium diammonium nitrate be used in combination with an acid but in a greater weight percent than the acid. Yano makes no connection between its oxidizing agent and RTN thin films.

Carpio, on the other hand, appears to be cited for the proposition that it discloses a pH adjuster at column 5. Indeed, Carpio is directed towards buffered slurries. However, Carpio does not teach or suggest any planarization between an RTN thin film and a patterned interlayer insulating layer. Carpio does not address the problems associated with RTN thin films at all. Accordingly, Carpio cannot supplement Yano with respect to the deficiencies of Yano as set forth above. Neither can Mueller as Mueller is clearly deficient for the reasons set forth above.

Accordingly, applicants respectfully submit that the rejection of claims 30-49 as being obvious in view of Yano, Carpio, the AAPA and Mueller is improper and should be withdrawn.

New claims 50 and 51 are limited to a slurry where the abrasive consists essentially of inorganic particles and has a pH ranging from 1 to 3. In addition to not being directed toward RTN thin film pattern formation and the problems associated therewith, none of the prior art references teach or suggest a slurry where the abrasive is limited to consisting essentially of inorganic particles. Further, with respect to claim 50, none of the prior art references are directed toward a slurry where the oxidant consists essentially of CAN.

Further, with respect to claim 51, none of the prior art references are directed toward a slurry having a buffer solution that consists essentially of an organic acid and its salt. Accordingly, applicants respectfully submit that new claims 50 and 51 are allowable as well.

An early action indicating the allowability of this application is earnestly solicited.

The Commissioner is authorized to charge any fee deficiency required by this paper, or credit any overpayment, to Deposit Account No. 13-2855.

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Respectfully submitted,

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